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SUMMER 1981

Big Sky Clearwater

VOL. XI SUMMER ISSUE 1981 NO. 2

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You think you've got problems!

See story on Page 1

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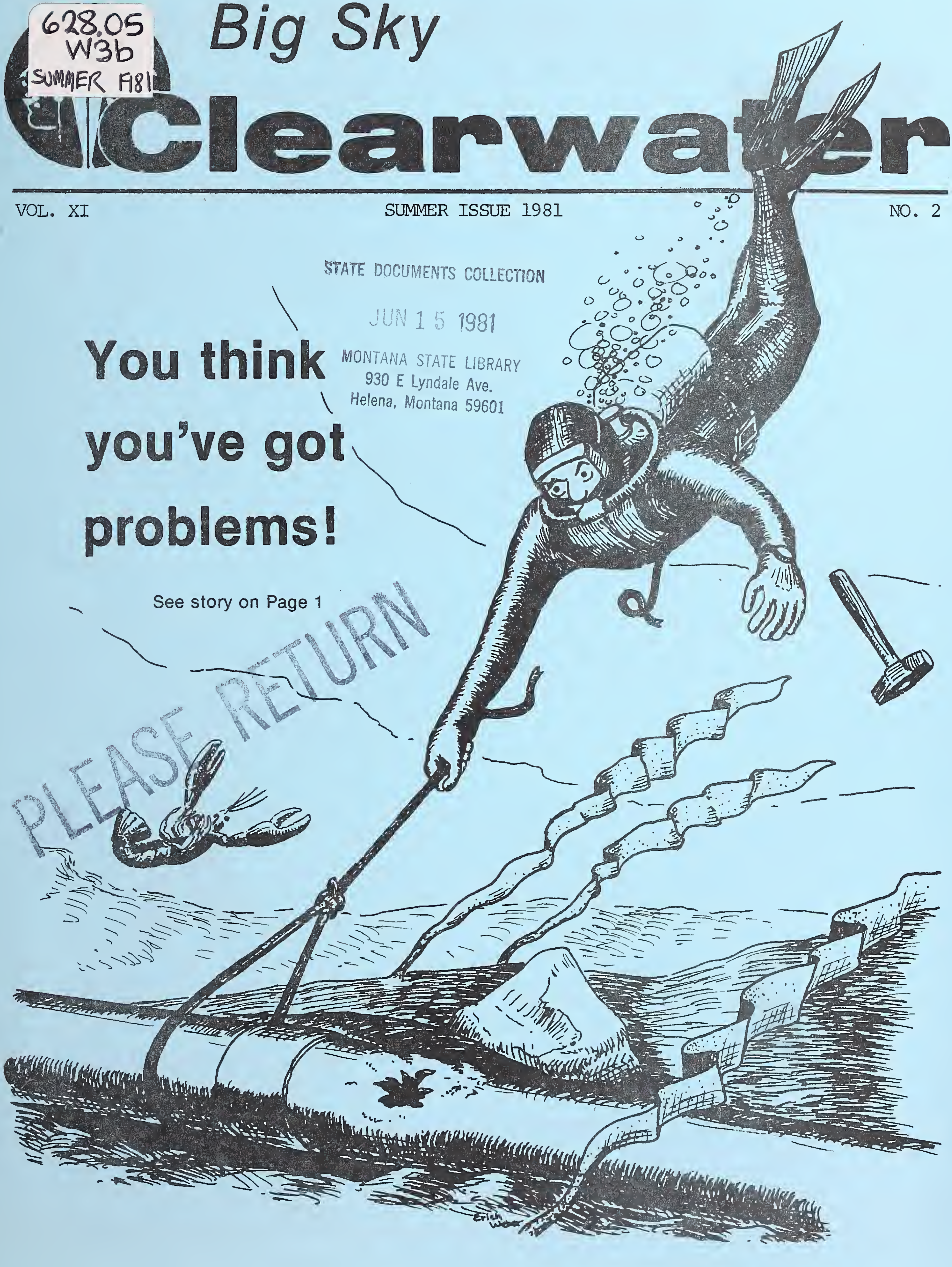

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Dangerous main at the bottom of bay

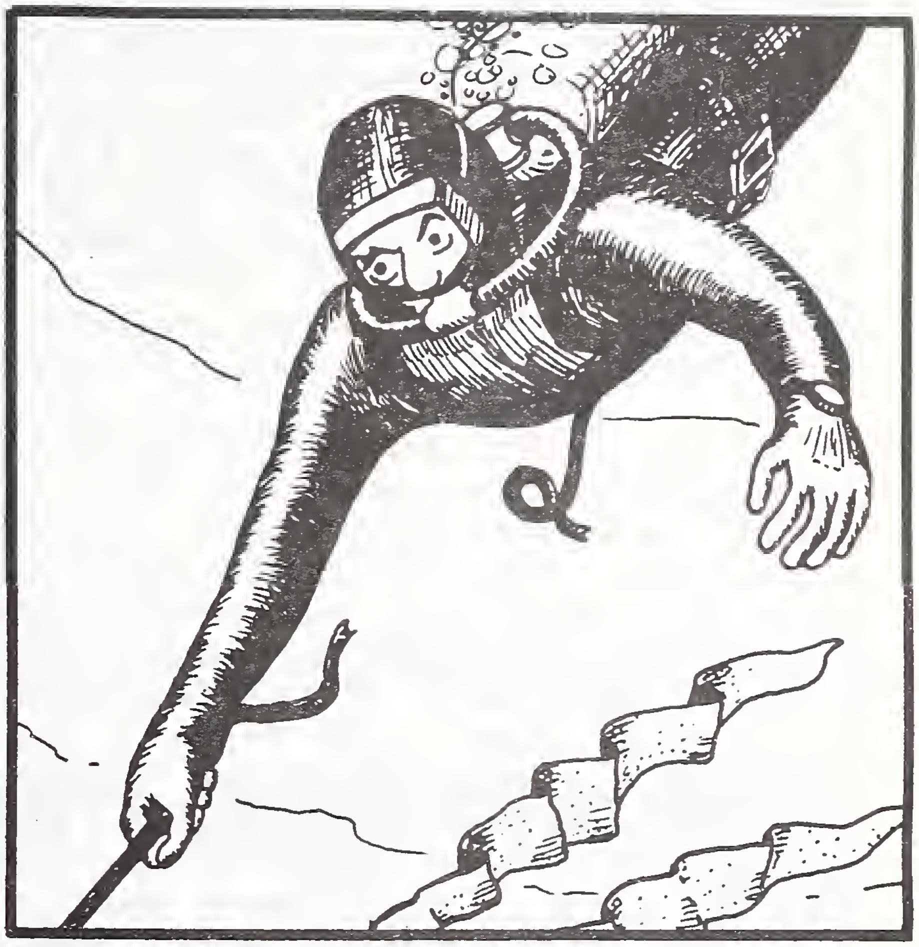
The repairmen vs. a rip-snorting tide

By John Schofield
WQB Environmental Engineer

THE NEXT TIME you're feeling overwhelmed by maintenance problems, consider what they have to go through in Eastport, Maine.

Eastport is the easternmost town in the United States -- on an island in Passamaquoddy Bay in eastern Maine. It was once a thriving fishing town, but it nearly died in the 1970s. All of the downtown businesses closed except for a grocery, a cafe and a general store. Half the homes were vacant. But before the town went under for good, an oil company bought half the island for a refinery.

This was the situation when I did some work in Eastport for the private company that runs the water works. It may have been a tiny place, but the job of getting drinking water to the island's inhabitants was immense -- and sometimes very dangerous.



The source of Eastport's water is on the mainland at Boyden Lake, which is about eight miles from Eastport across a channel with a real rip-snorter of a tide (upper Maine and New Brunswick have the biggest tidal fluctuations in the world).

The original water-delivery system

MSAWWA **MWPCA**

The Big Sky Clearwater -- for water and wastewater-treatment operators across Montana -- is published quarterly by the Water Quality Bureau of the state Department of Health and Environmental Sciences in cooperation with the Montana Section American Water Works Association and the Montana Water Pollution Control Association.

Editor: Charles Wood Graphics: Erich Weber
Publications Committee chairman: Joe Steiner

Publication dates: March 1, June 1, September 1, December 1. Last date to receive contributions is 21 days before publication. Mail contributed material to Charles Wood, Water Quality Bureau, Dept. of Health & Env. Sci., Room A206 Cogswell Building, Helena, MT 59620.

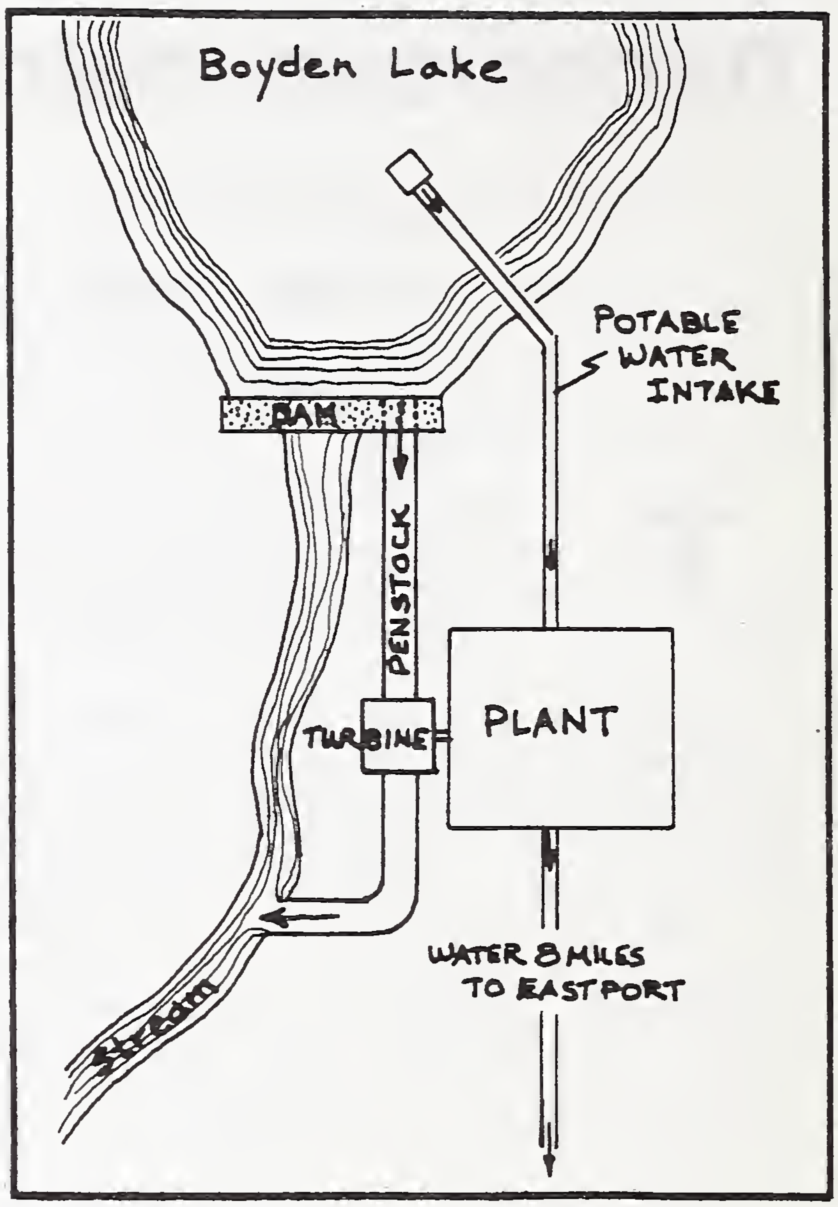
was put in at the lake in the 1870s and used a three-piston, double-action, plunger-type pump driven by a large water wheel. The pump and drive gear look like old-fashioned locomotive parts. The shaft from the water wheel (actually a water turbine -- all enclosed in a case and fed by a large five- or six-foot diameter penstock) is about four inches in diameter. The gear wheel is about five feet in diameter.

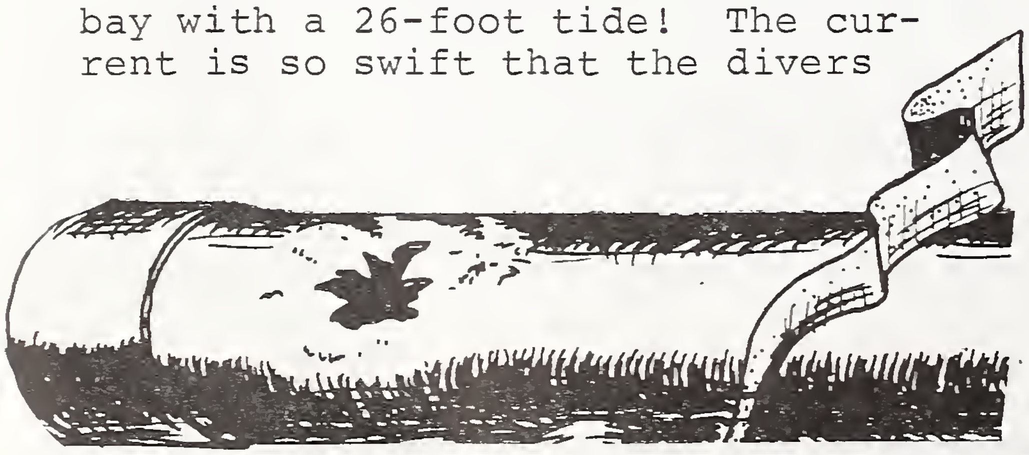
In the 1950s, pumps driven by eletric motors were installed, but the piston pump has always been used as a standby. Thunderstorms, windstorms, heavy wet snowfalls and freezing rain are continually causing power outages at the plant, forcing the need for the standby pump. And Maine is worse than Montana: winters start in December and run until April with no let-up; the snow never melts during that period, it just sits there; and 30-below-zero temperatures are common, sometimes a month will go by where the temperature never reaches zero!

The old piston pump, by its very nature, surges and creates a terrific water hammer. In 1975, repairs to mains or joints split apart by the old pump were costing about $500 a month.

Some of those main repairs are very difficult to attend to. About one mile of main lies under a bay. At low tide, the bay is nearly drained and the workers can walk across and look for leaks (in one or two feet of bottom muck, however). But the repair time is very short because the tide comes in very quickly.

Another portion of pipe crosses a narrow channel that drains a large bay with a 26-foot tide! The current is so swift that the divers have to be tied to the pipe to work. When the tide begins to go out, all work has to stop because the current is just too strong. Huge whirlpools even make it hazardous for the boats above. Once, a diver's rope broke during a repair job and he was swept, in a matter of minutes, three-fourths of a mile from the pipe to which he had been attached. Miraculously, he was found -- unconscious, but alive.





IF THE OIL REFINERY goes in, Eastport could afford (and would require) a new pump station and a 16- or 20-inch transmission line (the existing line is only 8 or 10 inches in newer sections). My project was to keep the old system held together until that time. Eastport could not be allowed to run dry -- mainly because of fire danger. The weatherbeaten wooden homes on the island were real fire traps.

Because of the leaks and the

serious breaks caused by the piston pump, I decided to abandon it as a standby. Instead, I designed a system that used the penstock and turbine to drive a generator that could be used to power the electric pumps. It would have cost about $16,000 to get that system into operation, but it might have saved $10,000 a year in power costs. Engineers figured the water turbine could produce enough electricity to run the entire plant.

I left the company, and Maine, in 1977 and headed west to Wyoming, then Montana. I never heard how my design turned out. I suspect it was never used because the new, larger pump station would be built to service Eastport and the new refinery. That would end the broken pipes under the bay.

But I still have nightmares that I'm a diver, tied to a pipe, and the tide is going out.■

Operator rescues girl from clarifier

Quick action by a plant operator may have saved the life of a 7-year-old girl who fell into a clarifier at a Montana sewage treatment plant.

Because of questions of safety concerning visitors wandering around plant grounds, the names of the plant location and the people involved in the March 8 incident will not be identified here.

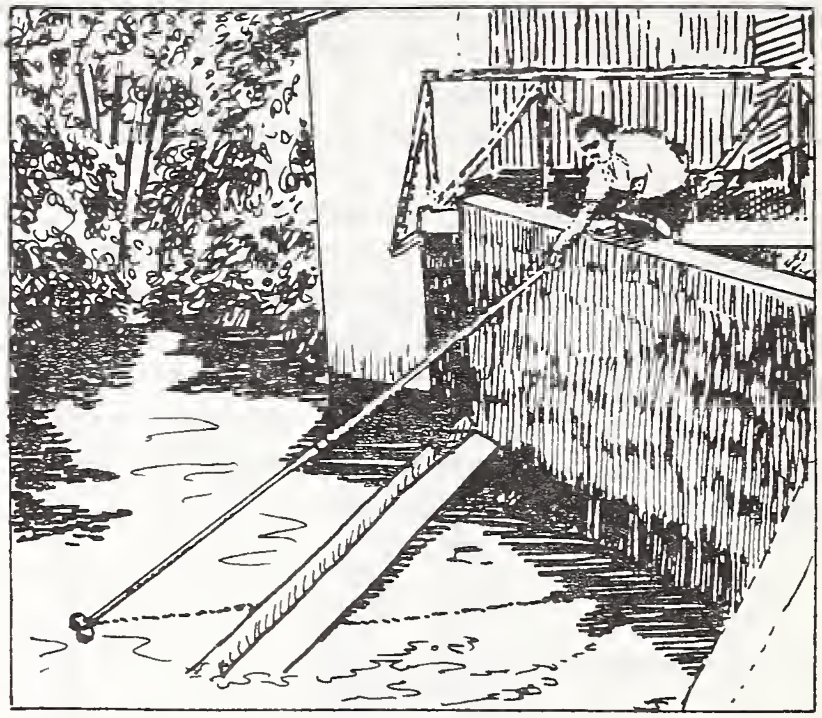
The girl was visiting with her family at the on-site residence at the plant. She had been playing with a large dog that lived at the site and decided to walk the dog around the plant grounds. They were following the plant operator as he conducted routine control tests throughout the plant.

The operator walked out onto the catwalk above the secondary clarifier followed by the dog and then by the little girl. As he started a test on the clarifier, the dog was startled and tried to retreat from the catwalk. As the dog turned around, it ran into the little girl, knocking her beneath the catwalk rail and into the clarifier.

The operator dropped his test equipment and ran to the side of the clarifier. By balancing on the weir and holding onto the catwalk, he was able to reach and rescue the girl.

Somehow, the girl had missed hitting her head on the rails as she fell, and she narrowly missed the clarifier weirs. She was startled and wet, but otherwise unhurt. The test equipment dropped by the operator was removed from the clarifier later, after the clarifier was drained.

An extension rod for your sampling probe

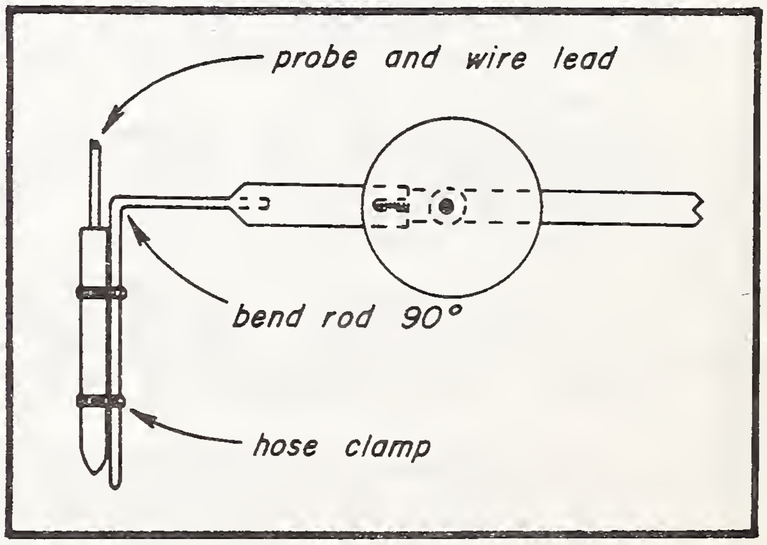


It's essential that you place sensing probes at the correct depth in water to accurately measure pH, temperature, conductivity and ion concentrations. Normally, one has to wade into the water or precariously balance a pole to which the probe has been attached.

The sampling rod described here permits sampling from the bank while allowing proper placement of the probe with the use of floats. It is easy and inexpensive (about $30) to build from readily-available materials, and its use greatly reduces time spent at a sampling site.

MATERIALS

- 12-ft. (or other desired length) aluminum telescoping paint-roller handle
- Standard paint-roller handle of the width desired
- Lead or other material for counterweight (appr. 1-in. dia. X 10 in.)
- 2 standard hose clamps
- 3-in. piece of ¼-in. all-thread rod
- Plastic cable ties
- Sheet-metal screws
- 2 plastic toilet-tank floats



ASSEMBLY

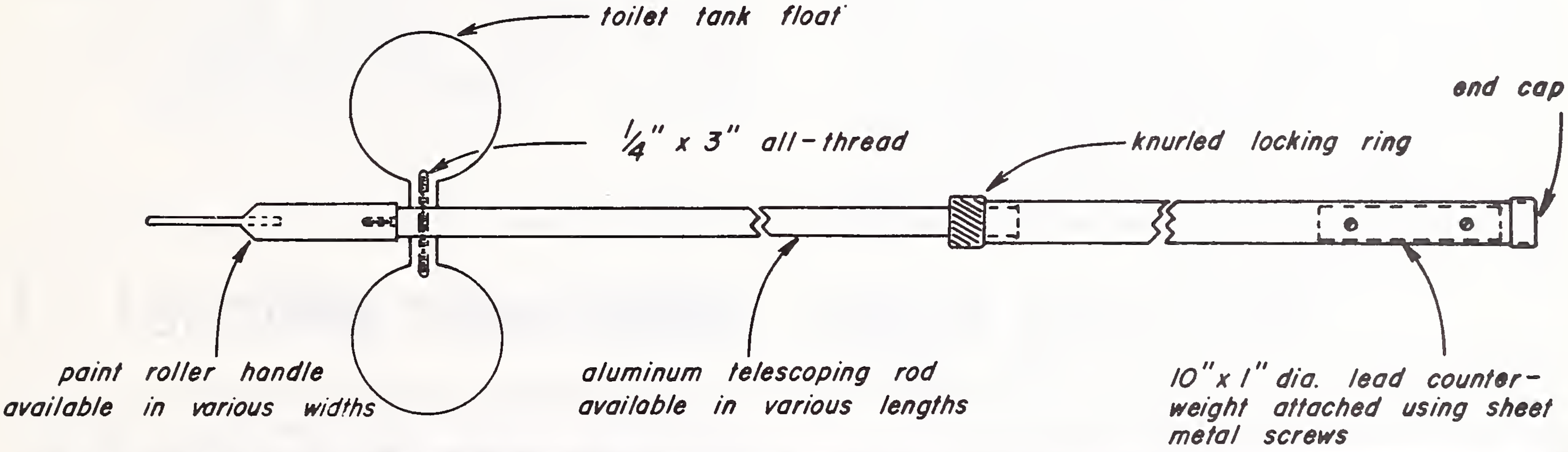
1 Fasten counterweight inside telescoping handle with sheet-metal screws. (The counterweight is optional, but users find that it improves balance when the rod is being used and carried.)

2 Remove the cover holder from the paint-roller handle, straighten the metal rod, and then bend the rod into a single 90-degree angle. Screw the roller handle onto the telescoping rod.

3 Drill a ¼-in. hole in the threaded end of the telescoping handle 1 inch above the threads. Make the hole perpendicular to the plane of the bent roller-handle rod. Insert the all-thread, and attach the toilet floats.

4 Attach the sampling probe to the metal rod with standard hose clamps (cushioning material may be desirable, depending on probe construction). Adjust probe to provide the correct depth for the electrode being used. (The maximum possible adjustment will depend on the width of the paint-roller handle chosen and where the 90-degree bend is made.)

5 With the telescoping handle fully extended, fasten the probe lead cable to the handle with plastic cable ties. Do not fasten between the float and the knurled locking ring, so that the handle may be collapsed and extended freely without interference from the cable.


toilet tank float
end cap
1/4" x 3" all-thread
knurled locking ring
paint roller handle available in various widths
aluminum telescoping rod available in various lengths
10" x 1" dia. lead counter-weight attached using sheet metal screws

There's a new way to chart the flow of the game

From Sports Illustrated

GO AHEAD AND LAUGH, but you can apparently learn a lot of interesting things from water pressure readings.

For example, the resort town of Ocean City, Maryland (pop. 35,000) used sewage-flow measurements to determine that it had exactly 225,582 visitors last July 4. The calculation was made on the basis of variations in the flow of wastewater computed by means of what scientists at Johns Hopkins University's School of Hygiene and Public Health, who developed the technique, call the "demoflush" factor.

Similarly, utility officials feel that water-consumption readings can provide a pretty fair idea of just how riveting major sports events and popular TV shows might be. That's because bathroom use during the most gripping events tends to decline for long stretches of time, then increases significantly during breaks in the action and again at the end of the show.

A case in point is the situation in Philadelphia during Super Bowl

XV last winter. As residents crowded around TV sets, the Philadelphia Water Department recorded that at 7:30 p.m., late in the first half, it was pumping water at a 290-gallon-a-day rate. By contrast, the flow at 8 p.m., during halftime, sharply increased to a 448-million-gallon rate. Obviously, Philly residents had been admirably biding their time up to that point.

But at 9 p.m., well into the second half, the rate declined only slightly, to 339 million gallons, suggesting that some Eagle fans had resigned themselves to the worst and were taking leave of their TV sets. At 10 p.m., after the game ended (the Eagles, of course, lost badly), the flow increased only to a 361-million-gallon rate.

The water department had expected a bigger post-game surge, but many Philadelphians probably had already turned off the TV, having long since realized that their beloved Eagles were going down the drain.

Martin City's water off again—with PSC's okay

The conflict over the Martin City water system continues. That's the system that was shut off by its owner, Wes Johnson, in the middle of the night (see Spring 1981 Big Sky Clearwater, Page 10) after problems had mounted up and he was denied a rate request. The residents became enraged and the system was forced back into operation.

Now, however, the system is shut down again -- but this time, with permission of the Public Service Commission. The water district -- through an engineering firm -- has been unable to establish the system's value -- so the district can buy it from Johnson -- because tests and water samples can't be run on a system that isn't operating.

So, since early May, the residents of Martin City sit without water. Will Aikin, head of the Water Quality Bureau's Kalispell branch, said a few residents already had drilled wells in case such a shutdown occurred, and a few others "are talking about drilling wells." The school, now out of session for the summer, got by in May on a cistern, and bar owners had to lease portable privvies, Aikin reported. But many residents face some hard times ahead if the district and Johnson don't resolve their conflict.

Johnson, who was asking $200,000 for the system, has come down to $165,000, Aikin said. But the district, which is trying to obtain federal funds, hasn't bitten. It feels the system is worth about $26,000.

Man your pencils!

A workshop to train local officials to design and operate effective community water-conservation programs will be held in Billings on Aug. 13.

The session -- sponsored by the Missouri River Basin Commission -- will include lectures, exercises, problem-solving sessions and a case study of a hypothetical community facing a water shortage. Participants will learn a seven-step procedure to devise a water-conservation plan for the community.

Mayors, city water plant operators, public works superintendents and others responsible for or concerned about community water supplies are encouraged to attend. For information write:
Missouri River Basin Commission,
10050 Regency Circle, Suite 403,
Omaha, NE 68114.

Association members elect officers

New slates of officers were elected for the Montana Sections of the American Water Works Association and the Water Pollution Control Association. The elections were held at the groups' joint conference in Butte in March. A total of 126 persons attended the conference.

The new officers are:

MSAWWA

National director
Mike Thomas, Billings
Chairman
Robert Sanks, Bozeman
Chairman-elect
Gary Mannix, Butte
Vice chairman
Robert Millons, Helena
Senior trustee
Hugh Wilkins, Great Falls
Junior trustee
Tim Berry, Helena
Secretary-treasurer
Dan Fraser, Helena

MWPCA

Federation director
Willis Wetstein, Helena
President
Larry Longfellow, Helena
President-elect
Martha Anne Dow, Havre
Vice President
Gerald Gaston, Billings
Senior trustee
Joe Steiner, Helena
Junior trustee
Dave Hudson, Helena
Executive director
Phillip Doughty, Butte

This newsletter needs your help

Hey out there! It's time we heard from you!

The Big Sky Clearwater is seeking articles from people all across Montana who are working in the water and wastewater fields. After all, this newsletter is supposed to be a communications link *between* operators, so it's only natural that some of our stories should be *written* by operators (also by consultants, engineers or anyone else who has an experience, mechanical problem or project to share with others).

We're a quarterly publication, of course, and articles should be submitted by about Feb. 1, May 1, Aug. 1 or Nov. 1 depending on the issue to the Editor, Big Sky Clearwater, Water Quality Bureau, Dept. of Health & Env. Sci., Room A206 Cogswell Bldg., Helena, MT 59620.

Or better yet, if you have an idea for a story, give the editor, Charles Wood, a call at 449-2406 and discuss it with him. He'd be happy to give you a hand in writing the story if you're the kind of writer who's still wondering why typewriter keys aren't in alphabetical order.

Also, feel free to write Letters to the Editor. We'll publish them, if you wish.

The Great Miscommunication Mystery

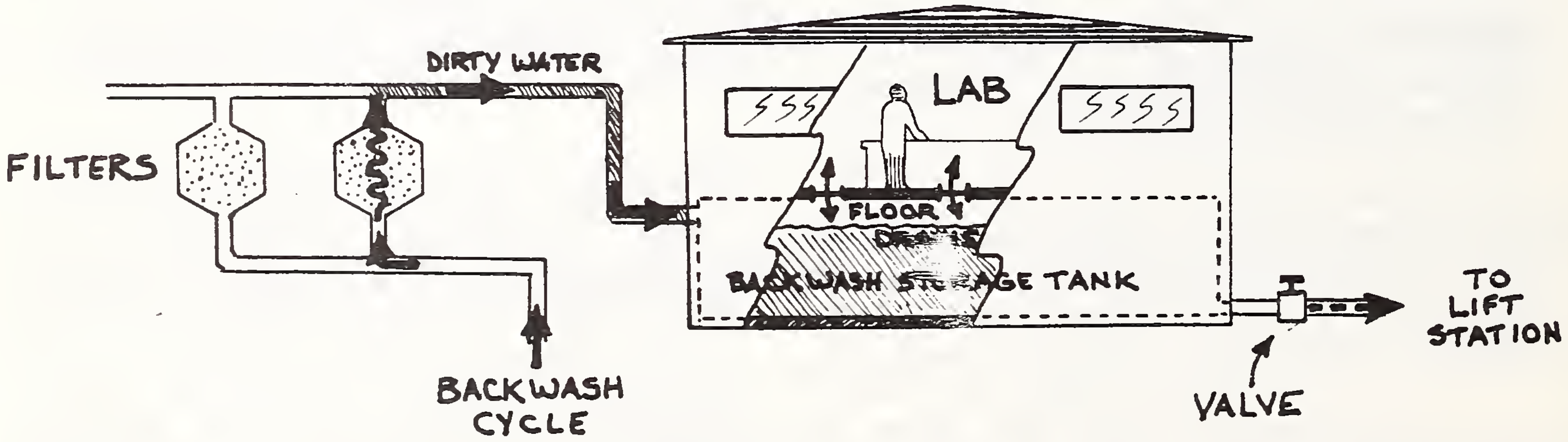
or:
How to ruin a softball game

By Tim Hunter
WQB Environmental Specialist

Alright, I confess. I was around when it happened. But don't blame me. Blame Larry. Or Bob.

LET'S GO BACK to that awful day, in the summer of '77. I was an operator at one of the two wastewater-treatment plants in Estes Park, Colorado. Larry, the other operator, and I were nearing the end of a long, hot workday, which included watering the lawn and swatting horseflies in the lab. The plant was running smoothly that day, no major problems.

The Estes Park plant has tri-media pressure filters which polish the effluent prior to disinfection. The filters are backwashed when the head loss gets too high. Backwash water is stored in a large tank under the laboratory, where it slowly drains to the lift station to mix with the plant influent (see diagram). This storage tank can hold the dirty backwash water from about two backwash cycles. Filter runs take about 18 to 24 hours, and it takes an hour for the dirty water from one backwash cycle to drain back to the lift station. Only one filter was being operated on the day I'm describing.



It was almost 5 p.m. Larry and I were to play in a softball game -- for the Number One spot in the league -- in an hour. We had put on our cleats and were heading for the pick-up when Larry noticed that the head-loss gauge on the filter was nearing the backwash level. He ran into the plant and pushed the button to start the automatic backwash cycle.

"Get it in gear," he yelled as he scurried out of the plant and into the truck. "We're gonna be late." I had already begun warming up for the game by popping open that which ain't no city beer.

"Good thing I noticed that filter," Larry said as we reached the ball field. "We'd've had a mess on our hands by morning."

IT WAS DURING the pre-game warm-up while Larry and I were playing catch when I spotted the familiar red pick-up driven by Bob, the plant superintendent. Bob was in a big hurry.

"What's the matter," Larry shouted after Bob screeched to a halt near the dugout.

"Plant's flooding!" Bob replied.

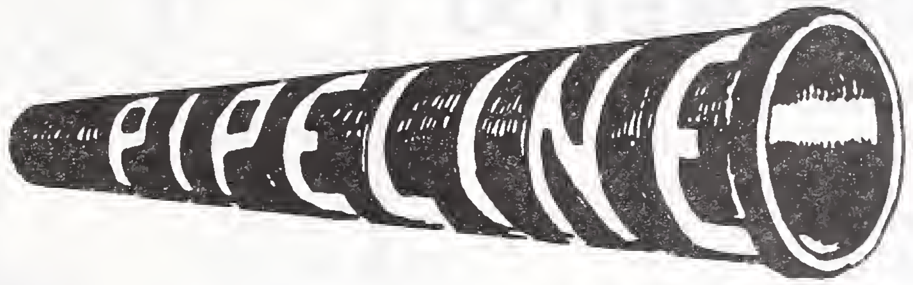
We three rushed back to the plant and were greeted by four inches of water in the reception area. The softball game, at least for Larry and me, was rained out from the ground up. All of a sudden, either Bob, Larry or I (I forget which) got a sinking feeling in his stomach because:

A. Bob closed the outlet valve on the backwash storage tank to make repairs to the lift station and forgot to tell us

B. Bob did tell one of us, but one of us forgot

C. The beer was downstream beer

It was either a failure to communicate or a failure to remember a communication -- I'll give you 30 seconds to figure out which. Just one more clue: it couldn't have been my fault. ■



Pump-station conference

Registrations are being accepted for a three-day Pump-Station Design Conference scheduled for Aug. 31 through Sept. 2 at Montana State University.

The conference will be divided into three categories: fundamentals, wastewater pumping, and water pumping. Fundamentals include: system design, pumps, drivers, transients, pipes, instrumentation, foundations, codes, blunders and costs. Wastewater pumping includes: siting, pump room layout, sludge pumping, electrical design, heating and ventilating, control, general arrangements, prefabricated stations and submersible pump stations. Water pumping includes: raw water, well water, finished water and sludge pumping, booster pumping, auxiliary systems, electrical, control, heating and ventilating, and station arrangements.

Enough proceedings will be printed in advance to supply each participant with a copy at the conference (proceedings will not otherwise be for sale). The proceedings, including discussions on papers from 47 authors and expected to be 1000 single-spaced pages, will be edited and revised to produce a three-volume textbook, probably in 1984.

The registration fee is $375. A ladies program is planned. For further information, call 994-2111, or write: Pump conference
Dept. of CE/EM
Montana State Univ.
Bozeman, MT 59717

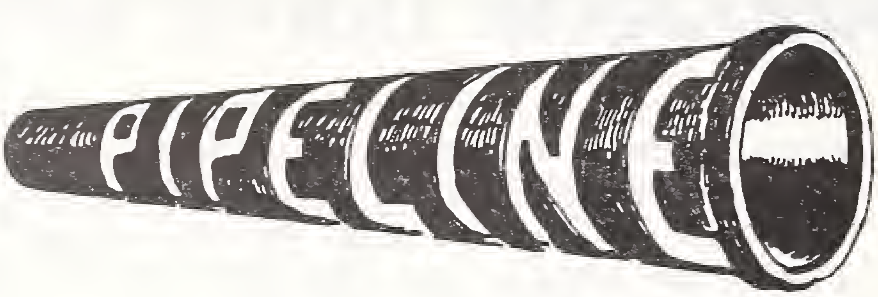
Grant for Indian training

The Joint Education Committee of MSAWWA and MWPCA has received a $15,000 grant from the EPA to conduct operator training on Indian reservations. Training exercises, conducted by Ken Johnston, already have been held at several reservation sites under the grant, and follow-up exercises are scheduled for August.

Next year's conference to be held in Helena

The MSAWWA-MWPCA joint conference for 1982 will be held on March 25-26 at the Colonial Inn in Helena.

There will be a meeting of the Program Committee in July to plan the program for that '82 conference. If you have any ideas for presentations, or know of any person willing to make presentations, please contact Jan Cranor before June 30, 1981, at the Water Quality Bureau, Room A206 Cogswell Bldg., Helena 59620 or at 449-2406.



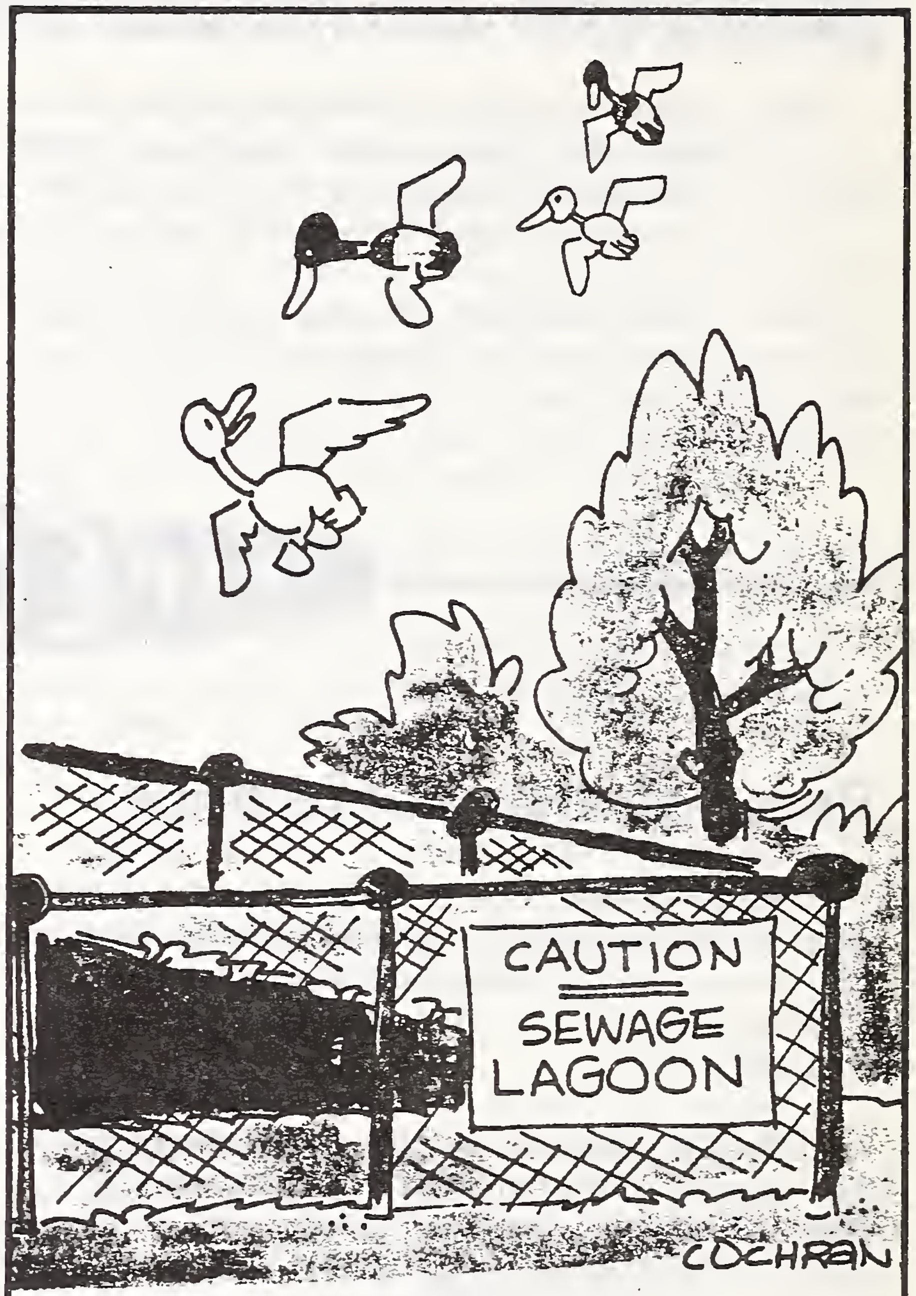
It's now called METCO

Montana's new Joint Training Coordinating Committee has been given a new name. It's now the Montana Environmental Training Coordinating Organization (METCO).

The name change was one of the accomplishments at the second organizational meeting on April 22 in Helena. Other accomplishments included: development of a constitution and by-laws, planning for a calendar of training events to be distributed quarterly, a discussion on membership and fees, and planning for METCO's first annual meeting (to be held in February).

METCO is being established to coordinate, evaluate and promote training in environmental concerns in Montana. People from the fields of water and wastewater technology, air quality, solid waste management and pesticide control are involved in METCO. A grant was received from EPA to set up the group.

Anyone involved in training in any of these areas who may wish more information about METCO may contact Tim Hunter, METCO president, at 449-2406.



"Come on. It can't be worse than the lake."

How to speak good: Lesson 1

weird / *'wi(ə)rd* / *adj.* 1. equipped or fitted with a weir. Example: *Montana has many weird water and sewage plants.*

Committee assignments announced

Assignments of MSAWWA and MWPCA members to 20 committees have been announced by officers of those groups. Members wishing to reject an assignment or wishing to be placed on a committee to which they were not named should contact Robert L. Sanks, MSU, Bozeman 59717 (if it concerns an MSAWWA or an MSAWWA-MWPCA joint committee) or Larry Longfellow, 931 Logan St., Helena 59601 (if it concerns an MWPCA committee). The assignments are:

MSAWWA-MWPCA Joint Committees

Auditing
Garry Mannix*
Jerry Gaston
Dave Haverfield
Mike Patterson
Gordon Ness

Cobleigh
Howard Peavy*
Wayne Young
Robt. Sanderson Jr.
John Morrison
Rod James

Education
Tim Berry*
Martha Anne Dow
Joe Steiner
Wade Weakley
Howard Peavy
Garry Mannix
Deanna Anderson
Mike Bowen
Denise Osterman
Jim Patterson
Mike Richards
Rod James

Govt. Affairs
Willis Wetstein*
Don Willems
Art Clarkson
Wayne Young

Manufacturers & Reps
Rob Balderston*
Bill Haldane
Warren Myers
Don Greenley
Dick Seevers

Meeting Place
Dick Nisbett*
Howard Peavy
William Pasco
Robert Haverfield
Alf Hulteng
Dave Brown

Nominations
Howard Smith*
William Pasco*
Dick Nisbett
Robert Haverfield
Ken Bevin
Rod James

Operator Certif.
Edward Schleinger*
Howard Peavy
Wayne Young
Ken Johnston
Don Willems
Deanna Anderson
Fred Hartson
James Patterson

Program
Jan Cranor*
Bob Millons*
Jim Kaercher
Dayton Alsaker
Howard Peavy
Denise Osterman
Wade Weakley
Rod James
A. Amirtharajah

Publications
Joe Steiner*
Dan Fraser
Willis Wetstein
Dave Brown
Robert Butcher
Wade Weakley

Resolution
Ken Johnston*
Mike Thomas
Phil Doughty
Don Willems
Roger Pierce

Safety
Garry Mannix*
Mike Patterson
Miles Tuttle
Bud Heiser
Dave Brown

* Denotes
chairman or
co-chairman

MSAWWA Committees

Community Relations
Dave Nichael*
Edward Schleinger
Dave Haverfield
Alan Towlerton

George Warren Fuller Award
Roger Pierce*
Robert Sanks
Leroy Lucker
Willis Wetstein
John Spindler

Membership
Alan Towlerton*
Art Clarkson
Garry Mannix
Deanna Anderson
Denise Osterman
Frank Leenknecht

Safe Drinking Water
Dan Fraser*
Wayne Young
Gerald Underwood
Art Clarkson

MWPCA Committees

Awards
Alan Edwards*
Bud Heiser
Joe Steiner
Bob Haverfield

Constitution & By-laws
Ken Johnston*
Don Willems
John Spindler
Alf Hulteng
Bill Pasco

MWPCF Industrial
Barry Damschen*
Mike Alberi
Phil Doughty
Bill Haldane

Membership
Dave Haverfield*
Phil Doughty
Larry Larsen
Alf Hulteng
Jim Patterson

57 pass the latest certification examinations

The Montana Board of Certification for Water and Wastewater Operators announced the certification of 57 persons as operators. Those passing certification examinations given on March 14 in Butte, Havre, Kalispell and Miles City are:

Class 1

Larry Anderson, C, Great Falls
Dana L. Audet, C, Great Falls
Douglas Ayers, B, Miles City
Earl W. Bahr, ABC, Great Falls
Leo D. Beimler, C, Libby
Kamla L. Bekemans, AB, Missoula
Sandra C. Blount, C, Havre
Eugene S. Brown, AB, Dillon
Stephen Cheman, C, Kalispell
Carl Christensen, B, Billings
Martha Dow, C, Havre
Mark R. Frahm, A, Great Falls
Sid Fredrickson, ABC, Kalispell
William Glenn, C, Chinook
Ronald Hamilton, ABC, Libby
Troy Jenrich, C, Colstrip
Blenda Jones, C, Libby
Margaret Joyce, C, Havre
Daniel Kinshella, AB, Great Falls
Rick Larson, C, Butte
Bryan K. Lewis, C, East Helena
Jesse Melvin, C, Billings
M. Harley Mott, C, Fort Peck
D. Ralph Nixon, C, Butte
Tamela Nulty, C, Great Falls
Thomas P. Nulty, B, Great Falls
Larry Powell, C, Miles City
Steven J. Quail, ABC, Billings
Bruce Taylor, ABC, Babb
Claudia Trembus, C, Havre
Allen Tudor, ABC, Kalispell
Wayne Vannice, C, Plains
Gary Van Tighem, C, Great Falls

Class 2

Ron Groseclose, AB, Hingham
Thomas Herrin, wells, Helena
Donald Hinman, lagoon, Baker
James H. Lipscomb, AB, Glasgow
Ettinge Little Owl Jr., B, Crow Agency
Ricky D. Russell, AB, Billings
Clarence Steinbacher, B, Fort Benton
Donald Sylvester, wells/lagoon, Shelby

Class 3

Robert Aitken, lagoon, Chester
Michael Barrash, AB, Missoula
Lewis F. Beer, C, Hamilton
James Billmayer, wells/lagoon, Kspl.
Steve Carlson, lagoon, Whitefish
William Cramer, wells, Lolo
Gregory Gill, lagoon, Boulder
Clinton Larson, lagoon, Plains
Dennis Ostroot, AB, Bigfork
James D. Smith, AB, Seeley Lake
Joseph Tackes, AB, Power
Eugene Brown, lagoon, Dillon

Class 4

Louis E. Brown, wells, Whitefish
Clayton Clifton, wells/lagoon, Hysham
Samuel Lynn, wells/lagoon, Denton
Tom Logan, wells, Wilsall
Lee Wolfe, wells/lagoon, Saco

(A = water-distribution certification; B = water-treatment operator certification; C = wastewater-plant operator certification)

The next examinations are scheduled for Sept. 18 at the Madison-Jefferson Room at Montana State University, Bozeman. Anyone wishing to take an exam must submit an application before Aug. 18 to the Montana Board of Certification for Water and Wastewater Operators, Dept. of Health and Env. Sci., Room A206 Cogswell Bldg., Helena, MT. 59620.

Operators' Certification Corner

SAMPLE TEST QUESTIONS

1. A pH of 5 is __________(acidic, basic, neutral)

2. The smallest portion of a pure chemical substance which can exist and still have the properties of the original substance is a

   a. compound
   b. milligram
   c. molecule
   d. atom

3. Write the chemical name for each of the following:

   a. H_2SO_4
   b. Cl_2
   c. $Al_2(SO_4)_3$
   d. $Ca(OCl)_2$
   e. H_2O
   f. CH_4

4. When backwashing a sand or media filter, the filter bed should be expanded about ______% for the most effective cleaning.

5. If the pressure within a filter bed becomes less than atmospheric, then a condition called __________ _________ will occur, resulting in reduced capacity and effectiveness of the filter.

6. The main gasses produced by an anaerobic digester are ________ and __________.

7. __________ is the process of washing sludge prior to chemical coagulation.

ANSWERS

1. acidic
2. molecule

3. a. sulfuric acid
   b. chlorine
   c. aluminum sulfate (alum)
   d. calcium hypochlorite
   e. water
   f. methane

4. 40%
5. air binding
6. methane, carbon dioxide

7. elutriation

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TO:

1,650 copies of this publication were produced at a unit cost of 33¢ per copy, for a total cost of $544.50 which includes $405.90 for printing and $138.60 for distribution.